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STATUS OF THE SORGHUM BLIGHT.

By W. A. KELLERMAN and W. T. SWINGLE.

Attention is called to two papers, whose titles in full are as follows:

(1) *Notizie preliminari sopra alcuni fenomeni di fermentazione del Sorgo saccarino vivente* (Preliminary notice concerning phenomena of fermentation in living saccharine sorghum). *Nota dei Socii corrispondenti Palmeri e Comes. Adunanza del dì* 1° *dicembre* 1883. *Estratto dal Rendiconto della R. Accademia delle Scienze fis. e mat. di Napoli. Fascicolo* 12° *dicembre* 1883.

(2) *Una Rivendicazione di Priorità sulla Malattia del Sorgo saccarino* (A vindication of priority concerning the malady of saccharine sorghum). *Pel Socio Dr. O. Comes. Adunanza del dì* 8 *agosto* 1889. *Estratto dal Rendiconto del Reale Istituto d' Incoraggiamento. Fascicolo* 7° *e* 8° *luglio e agosto* 1889.

The authors of the first paper, Professors Palmeri and Comes, noticed in 1882 in the expressed juice of saccharine sorghum minute forms similiar to ferments, but they made no further observations in regard to the same until the following year. In 1883 they found at Castellammare (Italy) that the canes presented a conspicuous coloration; in some cases the whole interior portion of the cane was red. This condition gave rise to the suspicion that here was presented the effect of the attack of *Ustilago Reiliana*, Kühn. But on the other hand, they noticed an increase of temperature in a bundle of canes, which was still more marked in a heap of reduced cane awaiting the extraction of the juice. The juice obtained was red in color and immediately underwent spontaneous alcoholic fermentation which was accompanied, or at least immediately followed, by an acetic fermentation. Examination was then made to determine whether fermentation took place in the juice previous to its extraction. For this purpose a cane was made use of that had been in store for eight days. It was cut into small pieces, put into water and subjected to distillation. The distilled liquid gave an alcoholic odor and furnished also, with Muntz's method, evidence of alcoholic content.

Professors Palmeri and Comes then sought to determine whether similar results would be obtained both in the vigorous growing canes attacked with the *Ustilago*, and also in healthy and uninfected plants. They took for this purpose from a farm at Ponticelli a few plants presenting the red discoloration, and others that showed no signs of the disease. Distillation one hour later resulted in the detection of alcohol in the case of the red canes, but none was found in case of the normal and healthy plants.

Sound canes were uniformly found to be white within, but affected ones were a red orange color. The coloration appears first in the fibrovascular bundles. It is light yellow, but in marked contrast to the adjacent tissue. Later the color deepens to a more or less intense orange, and the fibro-vascular bundles appear as red lines. Finally the adjacent tissue also becomes colored, first at isolated points and then throughout. At this stage the fibro-vascular bundles become altered to a brown color. The red coloration may be manifest, both in the tissue of the internode and in the leaf sheath, or it may be limited to the leaf sheath. In the latter case the corresponding fibro-vascular bundles of the internode are slightly yellow, and those of the leaf sheath are violaceous. But if the internodes and leaves are contemporaneously reddened it was found that the fibro-vascular bundles of the leaves first redden; then the coloration passes along the bundles into the stems. If the node be examined in longitudinal section the red strands will be seen entering from the leaf sheath. In fact the fibro-vascular bundles (with the surrounding tissue) are colored their entire length, and the coloration passes from the leaf to the node, thence with the elaborated sap through the internodes.

Upon microscopic examination the investigators found the red coloration to be due to a deposit on the cell walls. Under strong magnification colorless micro-organisms of various sizes and forms were detected. The larger ones were elliptical, the smaller almost spherical and highly refractive. The first propagate by budding and appear in colonies of two or three individuals united by germination. Some of them are homogeneous, but many present a luminous point in the center or a point at each end; still others have three points, namely, one in the middle and one at each end. The presence and number of these luminous points depend on the stage of development of the cell. Their length (5–7μ) is about twice their breadth (2-3μ).

These micro-organisms, according to Professors Palmeri and Comes, probably correspond to the species figured by Bonorden, Handb. All. Mykol. taf. I Fig. 2 and called *Hormiscium sacchari*. This ferment is very probably the same as that which was afterwards named by Rees *Saccharomyces ellipsoideus*. The spherical or subspherical micro-organisms mentioned above are scarcely 1μ long and present an active vibratory movement. They should perhaps be referred to *Bacterium termo*, Djr.,which is commonly found in juices and tissues undergoing decay.

A positive demonstration of the mode of entrance of the germs into the tissue is not claimed, yet it was suspected from observations above given that they enter from without—which is corroborated by the following. "Not only is there a whitish cereous coating, but also another, especially under the sheaths of the affected stems, which is frost-like, greasy white, and cinereous. Microscopic examination reveals the fact that this lime-like coating consists of myriads of organisms like those found in the juices. The diseased plants remaining on the ground afford in their amylaceous or saccharine contents opportunity for increase of the micro-organisms, which are then finally wafted hither and thither by the breezes. Disseminated in this manner they reach the leaves of the sorghum plants, upon which, in the presence of mists and rain, they multiply and pass through casual wounds or through stomates into the leaves, thence with the elaborated sap to the tissues of the stalk." This hypothesis is supposed to be justified further by the observation that the disease was more intense during the spring fogs and on manured soil where the development of such germs is common. This was the case at Castellammare, where the material for study was obtained.

We have thus given in detail the account of these interesting investigations (in fact this may be considered for the most part merely a free translation of the paper) though carried on five years ago, for the reason that no extended notice of the same has hitherto been given in this country. It was reviewed in the *Botanisches Centralblatt* XXIII, 19 (1885).

In the second paper "Vindication of Priority," Dr. O. Comes, after referring to Professor Burrill's and our own investigations of the Sorghum disease, calls attention to his researches published in 1883 and maintains most positively that the disease studied by himself and Professor Palmeri is the same as that discovered by Professor Burrill in Illinois and further studied by us in Kansas.

Professor Burrill's accounts are as follows: "A Disease of Broom-corn and Sorghum," in the eighth annual meeting of the Society for the Promotion of Agricultural Science, 1887, pages 30–36, and in the Fourteenth Report of the Board of trustees of the University of Illinois for the two years ending September 30, 1888, pages 215–222; and "Disease Germs; another illustration of the fact that bacteria cause disease," in The Microscope, Vol. VII, No. 11, pages 321–331, taken from the Transactions of the American Society of Microscopists, 1887. Our accounts are as follows: "Preliminary Report on Sorghum Blight" in Experiment Station, Kansas State Agricultural College, Bulletin No. 5, pages 56–60, December, 1888; and "Sorghum Blight" in the First Annual Report of the Kansas Experiment Station, State Agricultural College, for the year 1888, pages 281–315.

It is not so clear to us as it is to Dr. Comes that the disease detected by him is the same as that studied by us, and for conclusive evidence we await further investigation on both sides. Dr. Comes dealt with a form of disease characterized by evident alcoholic (and acetic) fermentation. No fermentation whatever was detected either by Professor Burrill or ourselves. Stress it seems to us should be laid on this fact.

He says, in reference to the microbe which he found, that he first thought he had to do with a saccharomycete, but convinced himself the following year that it was a schizomycete and referred to *Clostridium butyricum* (Pasteur), Praz. in "*Il marciume delle radici e la gommosi nella vite*, Napoli, 1884" We would note in reference to this species that according to Prazmowski, "*Untersuchungen über die Entwickelungsgeschichte und Fermentwirkung einiger Bacterianarten* and the description in Schrœter's "*Kryptogamen-Flora Schlesiens*," III, Band, Pilze, S. 166, it is a very different organism from *Bacillus sorghi*, Burrill. As figured by De Bary, "Lectures on Bacteria," 2nd. Ed., English translation, page 100, Fig. 13, it somewhat resembles the form shown by us, Plate IV. Fig. 5, *l. c.* which is wholly unlike *Bacillus sorghi.* In the latter no germination of the spores could be seen, while in *Clostridium butyricum* they are said to germinate from the end and are so figured by Prazmowski, *l. c.*

Dr. Comes further says that not having material at hand at the time of writing the "Vindication" he was unable to confirm his former reference of the microbe to the one previously described or to determine whether it be new (*Bacillus sorghi*) as Professor Burrill decided. He says that the description and figures given by Bonorden correspond precisely to the microbe under examination, and also states that his own description of the organism corresponds exactly to that made by Burrill, and to the Figures 1, 2, 3, 4, 5, and 6, Plate IV, of the Report of the Botanical Department of the Kansas Experiment Station, 1888, except that his is a little larger than ours. Now, it should be noticed that whereas our Figures 1, 2, and 3 represent the *Bacillus sorghi*, Figures 5 and 6 represent Bacilli very different in size and character and only occasionally found as impurities in cultures.

The difference in size of the micro-organisms found by Dr. Comes and of *Bacillus sorghi* is by no means inconsiderable. His were 5–7μ long and 2–3μ wide. The measurements of *Bacillus sorghi* are only $1\frac{1}{3}$–4 by $\frac{1}{2}$–$1\frac{1}{4}\mu$, mostly $1\frac{1}{12}$–3 by $\frac{3}{4}$–1μ. Moreover, if Bonorden's figures (taf. I, Fig. 2, and description of species page 33, *l. c.*) be examined it will be seen that they are very different from our figures of *Bacillus sorghi* referred to by Dr. Comes, and Bonorden's can not for a moment be regarded as representing the species with which we had to deal.

The *Micrococcus* figured by us (Plate IV. Fig. 4. *l. c.*) was also found by him and referred to *Bacterium termo.* The figure alluded to, no less than our (unpublished) description of the organism, shows that it is not *Bacterium termo*, but a *Micrococcus* measuring only $\frac{1}{2}$–$\frac{3}{4}$ μ in diameter.

The interior tissue of the cane when diseased (and the disease appeared within only where the stalk had been wounded) was uniformly colored in specimens examined by us. We found in no case colored fibro-vascular bundles surrounded by white tissue. Dr. Comes found the fibro-vascular bundles either light yellow or highly colored and surrounded by white tissue.

The disease in Italy was found in the saccharine sorghum, presumably *Sorghum saccharatum;* that which we studied is in *Sorghum vulgare*, and so far as known to us at present does not occur on *Sorghum saccharatum.*

Finally we observe that the symptoms of the sorghum disease reported by Dr. Comes do bear, at least superficially, a marked resemblance to sorghum blight studied by us, yet at the same time the microbes appear to be quite different. At any rate a fuller diagnosis, showing more points of resemblance, may perhaps reasonably be expected in order to establish the identity of the disease occurring in Italy and in the United States.

NOTE BY T. J. BURRILL.

Through the kindness of Professor Kellerman I have had an opportunity to examine the manuscript by himself and Mr. Swingle in reply to the respectful claim of priority on the part of Dr. Comes in the matter of sorghum blight. The reply seems to me well made and fairly states the case upon both sides. I will here say that I had seen the notice in the *Botanisches Centralblatt*, XXIII. 19 (1885), before my first paper upon the subject was published, and really intended to refer to it. However, it seemed certain to me that the disease there alluded to could not be that with which I was engaged. This certainty was the primary cause of the omission of my intended reference, since I filed my note made at the time of reading the article among those of general plant diseases instead of among those due to bacteria, and thus overlooked it when the manuscript was prepared. Further, the tissues of growing sorghum plants are very likely to turn red when injured in any way, even by mechanical wounds, while the fact that alcohol was cited as a product and a *Saccharomycetes* as an agent clearly separated the characteristics of the diseases studied. It is certain that alcohol is not found directly connected with what is called sorghum blight in America. It seems to me impossible that any one could mistake the organism described as the cause of this last for either *Bacterium termo* or *Clostridium butyricum*, not to speak of a *Saccharomycetes*.

However, if this sorghum blight was really investigated in Italy before it was in America, no one will more cheerfully accept the fact than myself whether or not the authors properly described what they saw.

ROOT FUNGUS OF NEW ZEALAND.

By R. Allan Wight.

This fungus in the mycelial stage attacks a great variety of tree roots, amongst the most conspicuous of which are the apple, pear, peach, and all other common orchard trees. The white thorn is also very subject to its attacks, as well as a great many *Abies* and several of the native trees and plants. It also attacks the cabbage, the potato, docks, sorrel, fern, and in fact is almost omnivorous, which is a marked peculiarity.